# A CONTRIBUTION TO THE SURGICAL ANATOMY OF THE MIDDLE CRANIAL FOSSA,

## WITH SPECIAL REFERENCE TO OPERATIONS FOR THE REMOVAL OF THE GASSERIAN GANGLION.[1]

(From the Anatomical Laboratory of Washington University.)

By WILLARD BARTLETT, M.D.,

OF ST. LOUIS.

My limited experience, gained by removing the Gasserian ganglion but three times, has been sufficient to show that we require, for the accurate performance of this procedure, more exact knowledge of the middle meningeal artery and the floor of the middle cranial fossa than is contained in text-books on anatomy. At the first operation the artery was seen coursing across the field after the bone opening had been made as advised by Cushing;[1] in the second case the technique employed was the same; still, this vessel was seen at no time; while in the third, I cut with the first stroke of the chisel a middle meningeal which lay in an unusually deep groove. That it is desirable to avoid such an accident, all who have ever experienced or seen it will agree with me. Still, none of the forty works on anatomy which I have examined give us much help in this matter by even mentioning this as being a very irregular artery, or by furnishing us with the usual dimensions of the parts which engage our attention; hence I have photographed a number of unusual middle meningeal grooves, as well as made careful measurements on the floors of 100 fossæ, in the hope that the averages thus obtained might be of use in simplifying a surgical procedure which is generaly regarded as very difficult.

[1] Read before the St. Louis Medical Society on February 1, 1902.

The operations to which I have referred were done October 10, 1900; November 28, 1900, and September 24, 1901. The first two were reported in the ANNALS OF SURGERY of June, 1901, while the third is as yet unpublished; all three resulted favorably, although section of the middle meningeal artery came very near costing the third patient her life.

I am indebted to Professor Terry, of Washington University, for having placed at my disposal the skulls of the museum at the medical school, as well as those which are used for teaching purposes in his department. I regret that I could not see these heads before dissection; still, the specimens chosen from this material are presumably all of the adult type, and certainly in great part belong to male skeletons, as will be readily appreciated by those who are familiar with our dissecting-rooms, whence these bones are derived. In this series no attention is paid to the cause of death or to the nationality of the individual skull's former owner. I am well aware that the dimensions of the skull vary in the different races, and with various morbid conditions, hence have, for this very reason, sought to subserve the interests of practical surgery by disregarding the fact and furnishing working averages.

The character of the floor of the middle cranial fossa is a matter of decided interest to the operator who would attack the ganglion by the temporal route, the one now most in vogue, since, from this bony field, the dura mater must be stripped before the second and third branches can be seen or reached. Every one who has done the operation a few times must have noted that it is often difficult, or even impossible, to approach the foramen rotundum or ovale until certain bony inequalities have been chiselled away. This had been my experience in two of the three cases above referred to; still, I was hardly able to appreciate the endless variety of ridges and eminences which render this surface irregular, until I had examined a large number of skulls. In fact, one can say, with justice to the truth, that the interiors of a number of skulls are no more alike in appearance than are the exteriors of the soft structures which clothe and adorn them. Inter-

esting in this particular are the conclusions recently made by Dr. Amyx,[2] of this city, in his "Observations and Remarks on Removal of the Gasserian Ganglion in the Cadaver." In one of the specimens examined by me the conditions for operation would have been particularly annoying; here there was a well-defined and sharply cut cavity for the reception of the ganglion and its branches, and of such depth that a ganglion of the usual dimensions must have lain with its upper surface flush with the bony floor of the middle fossa.

The anatomists give us no inkling of the fact that the foramen rotundum is not always round and that the foramen ovale is by no means always oval; nevertheless, such is the case. I must say, however, that the foramen ovale is much less regular in shape and size than its smaller mate. It was seen in 100 instances to assume every form between a long, narrow slit and a perfectly round opening, so was in many cases far from the "oval or half-oval" of v. Bardeleben[3] with its cross-axis of 5.8 millimetres. One might supppose, from studying the various works on anatomy, that the foramina rotundum, ovale, and spinosum were constant as regards the directions in which they transmit respectively the second trigeminus branch, the third trigeminus branch, and the middle meningeal artery through the floor of the skull. This is far from the truth, however; the directions of their courses vary greatly in the different individuals.

The bone opening as made by Cushing in approaching the ganglion has for its lower margin the infratemporal crest, a ridge in which too much dependence is not to be placed, since it is demonstrated by my series to be inconstant. In two instances there was absolutely no sign of any such structure, while in a number of others it was so faint as to have made detection of it during a surgical operation highly problematic, if not altogether impossible. It is, however, a useful landmark when present, and represents the point at which the operator must begin to strip the dura mater from the osseous floor, proceeding towards the ganglion a distance which is measured on the outside of the skull by the space

which intervenes between the crest and the foramen rotundum or ovale. Now, it may save an operator some embarrassment, especially if the case be his first, to know the average width of the middle cranial floor between the points mentioned, or, in other words, to know how far he will have to elevate the dura mater before he can attack the envelopes of the ganglion at one of these two points of least resistance.

Of the two foramina, the ovale is far the more accessible on the exterior of the cranium; so I measured the distance between this opening and the infratemporal crest at a point when the latter is crossed by the sphenotemporal suture and found as follows:

DISTANCES BETWEEN FORAMEN OVALE AND INFRATEMPORAL CREST.

| | | | |
|---|---|---|---|
| 17 | millimetres in 3 cases. | 22.5 | millimetres in 4 cases. |
| 18 | millimetres in 7 cases. | 23 | millimetres in 7 cases. |
| 18.5 | millimetres in 2 cases. | 23.5 | millimetres in 1 case. |
| 19 | millimetres in 10 cases. | 24 | millimetres in 4 cases. |
| 19.5 | millimetres in 1 case. | 24.5 | millimetres in 2 cases. |
| 20 | millimetres in 11 cases. | 25 | millimetres in 4 cases. |
| 20.5 | millimetres in 5 cases. | 25.5 | millimetres in 1 case. |
| 21 | millimetres in 14 cases. | 26 | millimetres in 3 cases. |
| 21.5 | millimetres in 6 cases. | 27 | millimetres in 3 cases. |
| 22 | millimetres in 8 cases. | 30 | millimetres in 2 cases. |

Thus from these figures is deduced as an average 21.5 millimetres, the distance which the surgeon must traverse over the floor of the middle cranial fossa before he can reach the point of exit of the third branch of the trifacial at the foramen ovale. It is, however, customary to attack the envelopes of the ganglion at the foramen rotundum, and the figures above quoted answer about equally well for it as for the foramen ovale, the two openings being almost equally distant from the infratemporal crest at the point where it is crossed by the sphenotemporal suture.

Having the above, it is none the less necessary that we, as surgeons, know the average anteroposterior dimension of our field of operation, represented by the distance between the anterior border of the foramen rotundum and the posterior

border of the foramen ovale. It is, indeed, surprising to note how little aid is to be derived, in this particular, from books on anatomy. The text-book writers of the last 164 years, as far as their works are at my command, have favored us with but meagre details as regards the average distances between the various points on the floor of the skull. The exact amount of bone which separates the foramina rotundum, ovale, and spinosum is entirely ignored by Keill[4] and Cloquet,[5] while Wistar[6] merely mentions that the ovale is half an inch behind the rotundum. Meckel[7] writes nothing of distances, but Horner[8] informs us that the ovale is eight lines behind the rotundum, while the spinosum is still two lines farther back. That is all, however, for one must look in vain after any records of measurements in the works of Horner[9] (special anatomy), Masse,[10] Smith,[11] Arnold,[12] Wilson,[13] Bock,[14] Quain,[15] Richardson,[16] Jamain,[17] Dursy,[18] Hyrtl,[19] Sappey,[20] Henle,[21] Ward,[22] Pansch,[23] Allen,[24] Merkel,[25] Weisse,[26] Holden,[27] Hyrtl,[28] Heitzmann,[29] Heitzmann[30] (a later work), Thane,[31] McClellan,[32] Gray,[33] Holden,[34] Gegenbauer,[35] Spalterholz,[36] Tillaux,[37] Deaver,[38] Gerrish,[39] v. Bardeleben,[40] Morris,[41] Hermann,[42] Morton,[43] or Bonamy and Broca.[44]

Nevertheless, the surgeon who is acquainted with the average dimensions of his field of endeavor is manifestly better equipped than he who possesses no such data, hence I have tried to supply what is desirable in regard to the average distance from the anterior border of the foramen rotundum to the posterior border of the foramen ovale.

In 100 instances this anteroposterior measurement was found to vary from 16 millimetres to 27 millimetres, and this in skulls whose dimensions showed very little difference in other respects. No one can doubt that it is a matter of some importance to the surgeon to know that one of the important distances with which he has to deal may be almost twice as great in one head as it is in another of the same size; especially as this can be discovered in the individual instance only after he has arrived at the bottom of a deep operative well, in which the powers of vision are limited at best.

DISTANCES BETWEEN FORAMEN ROTUNDUM AND FORAMEN OVALE.

| | | | |
|---|---|---|---|
| 16 | millimetres in 1 case. | 21 | millimetres in 12 cases. |
| 16.5 | millimetres in 1 case. | 21.5 | millimetres in 6 cases. |
| 17 | millimetres in 3 cases. | 22 | millimetres in 15 cases. |
| 17.5 | millimetres in 5 cases. | 22.5 | millimetres in 1 case. |
| 18 | millimetres in 8 cases. | 23 | millimetres in 3 cases. |
| 18.5 | millimetres in 7 cases. | 23.5 | millimetres in 1 case. |
| 19 | millimetres in 12 cases. | 24 | millimetres in 7 cases. |
| 19.5 | millimetres in 1 case. | 24.5 | millimetres in 1 case. |
| 20 | millimetres in 9 cases. | 25 | millimetres in 2 cases. |
| 20.5 | millimetres in 4 cases. | 27 | millimetres in 1 case. |

Thus the average distance was found to be 20.4 millimetres, which can be said to be the length of the slit one may expect to make in the envelopes of the ganglion, in order that its body may be freed together with the second and third branches. Through this same size opening the first branch can be dissected, likewise the sensory root, if a curved spatula be used.

Even more important than the foregoing is exact knowledge of the usual distance between the foramina ovale and spinosum, since through the latter passes the middle meningeal artery, and through the former the third branch of the trigeminus; two structures which must be cleanly separated before the ganglion can be removed in its entirety. Certain surgeons, among them Lexer,[45] Murphy,[46] and Friedrich,[47] have torn off the artery at this point without any very serious result; still, in general, it must be said that the accident is one of the most unfortunate which can complicate the operation, usually bringing the same to an untimely close, and greatly endangering the life of the patient. It is, then, in view of all this, very important for us to know that the relation between the two foramina, and hence between the nerve and artery, is exceedingly variable, a point which Dollinger[48] demonstrated quite recently.

In one of the middle fossæ which I measured, there was no foramen spinosum at all, the artery coming into the cranial cavity, as its groove indicated, through the foramen ovale alongside of the third branch of the fifth nerve; had this sub-

ject been operated upon, the artery could hardly have escaped injury. Knowledge of such a possibility is, however, none the less desirable, for he alone who is forewarned can be forearmed. The other extreme is illustrated by another of my skulls in which the opening for the entrance of the middle meningeal was situated a distance of 18 millimetres from the foramen ovale. It is scarcely possible to conceive of the artery being encountered under these circumstances.

Between these two extremes were found the greatest variety of conditions existing in the different skulls,—some of them would, as will be seen from the table below, have favored an easy operation, while others must have tended to render the same very difficult.

DISTANCES BETWEEN FORAMEN OVALE AND FORAMEN SPINOSUM.

| | | | |
|---|---|---|---|
| 0.5 millimetre | in 4 cases. | 4 millimetres | in 14 cases. |
| 1 millimetre | in 6 cases. | 5 millimetres | in 8 cases. |
| 1.5 millimetres | in 5 cases. | 5.5 millimetres | in 3 cases. |
| 2 millimetres | in 23 cases. | 6 millimetres | in 1 case. |
| 2.5 millimetres | in 13 cases. | 7.5 millimetres | in 1 case. |
| 3 millimetres | in 14 cases. | 18 millimetres | in 1 case. |
| 3.5 millimetres | in 6 cases. | | |

Thus it is seen from these figures that an average distance of 3 millimetres separates the openings through which pass the middle meningeal artery and the third branch of the trigeminus, a space in which the operator has, with careful work, sufficient room for the manœuvres required for the dissection of the posterior surface of the third branch, without exposing the vessel to danger.

Dollinger [49] found that even when sufficient bone separated the two openings just considered, the posterior border of the spinosum lay in front of the anterior border of the ovale in 6 per cent. of his cases, and thus the artery rendered the third branch inaccessible from the Krause [50] bone opening by being directly between the two. He therefore concludes that the operation is possible of accomplishment in 6 per cent. of cases only after the external carotid (from which the middle meningeal is derived) has been ligated; a procedure

which Davis,[51] Spellissy,[52] and others have warmly advocated. Should the middle meningeal so placed be discovered before it had been torn, it might, it seems to me, be possible still to dissect out the ganglion without tying the carotid, by working in front of and to the inner side of the vessel with a curved spatula or elevator. The plan were worth a trial, at any rate.

In comparing the two sides of the skulls examined by me, a marked asymmetry was noted. Thirty-four of the middle fossæ under consideration belonged to seventeen skulls which had not been sawn through the median line, so I was easily able to make direct comparison, in them, of the three dimensions now under consideration. The distance from the infratemporal crest to the foramen ovale on the right side averaged 20.5 millimetres, that on the left averaged 20.9 millimetres. The average space which intervened between the anterior border of the foramen rotundum and the posterior border of the foramen ovale on the right side was 21.2 millimetres, on the left, 20.5 millimetres. The bony partition separating the foramina ovale and spinosum measured, on an average, right, 3.38 millimetres, left, 2.80 millimetres; giving us the two first-named dimensions greater on the left side, and the last named considerably larger on the right. I mention this matter only for what it may be worth; the number, seventeen, is, of course, far too small to furnish us with reliable working averages.

It will be noticed from the above that the distance between ovale and spinosum is greater on the right side, where that between rotundum and ovale is shorter; an observation which struck me so forcibly, while determining these measurements on the same side, in single instances, that I determined to institute a comparison of the extremes of all these dimensions in order to see if practical surgical deductions might not be drawn therefrom. It was found that the average of the fifty smallest spaces separating rotundum and ovale was 18.6 millimetres, while the average of the spaces between ovale and spinosum in the same fossæ was 2.9 millimetres. However, the fifty fossæ which gave the largest space between rotundum

and ovale, averaging 22.3 millimetres, showed an average of but 3.1 millimetres between ovale and spinosum; this being, contrary to what one might expect, a *relatively* shorter distance between ovale and spinosum in those cases which give the longer distance between rotundum and ovale. The following mathematical calculation demonstrates the truth of my statement,—18.6 : 2.09 :: 22.3 : $x$ ($x$ equals 3.5); hence the distance between ovale and spinosum would have to average at least 3.5 instead of 3.1, as I found it, if it were relatively as great in those cases which have the longer dimension between rotundum and ovale as it is in those having the shorter. The matter is certainly one of striking interest; and it must be of surgical importance to know that in 100 fossæ the closer the third trigeminus branch was to the second the farther the third and middle meningeal arteries were apart, and *vice versa*. This tendency becomes much more apparent when a smaller number of extreme cases are compared. Take, for example, our fourteen fossæ which show the shortest distance between the ovale and spinosum, having an average of but .89 millimetre, less than one-third the normal for the whole 100; these same give an average measurement of 20.3 millimetres between their rotundum and ovale; a surprisingly large figure when we consider that it is but one-tenth of a millimetre short of the average obtained for this dimension in all the skulls examined. On the other hand, the fourteen which averaged the highest between ovale and spinosum, viz., 6.32 millimetres (normal, 3.0), furnished an average of but 19.5 millimetres from rotundum to ovale, smaller, even, than that of the skulls whose ovale and spinosum were closest together. Thus in the one set of cases the relation between the rotundum-ovale and the ovale-spinosum dimensions was represented by 3.1 to 1, and in the other by 22.7 to 1; a marked difference in supposedly normal skulls, to say the least.

It is vastly more important to the surgeon, however, to study the matter in a way which is the reverse to that which has just been given; for he will, so to speak, have given the rotundum-ovale dimension, while that from ovale to spinosum

must be determined and is of vital importance, as upon it depends whether or not the third branch, together with the intact ganglion, can be removed without the vessel being torn. It may be argued that the operator should see the artery at the point where it penetrates the floor of the middle fossa, and thus be in a position to protect it. This can only be answered by saying that such a desirable possibility exists in those rare cases where venous hæmorrhage is slight during the whole operation, and in no others. In one of my three operations I had passing glimpses of the artery now and then, while in the other two I never saw the portion of it which is now under discussion. Taking 20.4 millimetres as the normal distance from the foramen rotundum to the foramen ovale and 3.0 millimetres as that from the ovale to the spinosum, I was surprised to ascertain that my fifteen middle fossæ which presented the shortest space between rotundum and ovale, averaging but 17.4 millimetres, gave the relatively high average distance of 3.6 millimetres between ovale and rotundum; the two measurements being in the ratio of 4.78 to 1. On the other hand, the fifteen fossæ which showed the highest average distance between rotundum and ovale, viz., 24.1 millimetres, measured on the average but 2.4 millimetres from ovale to spinosum, dimensions which are in the ratio of 9.79 to 1.

These measurements, when considered thus from various stand-points, seem to me sufficient warrant for the assertion that the operator may expect to find the middle meningeal artery, at the point where it pierces the floor of the middle temporal fossa, farthest from the third branch of the trigeminus, in just those cases which show the first and second branches to be nearest together. Under such circumstances, injury to the artery at this point is scarcely to be feared; but the surgeon must be exceedingly wary in the further development of a case in which he has found the first and second trigeminal branches far apart, for it is in such a cranium that he may expect to find the vessel very close to the third branch.

This artery again becomes an object of decided interest to us in that part of its course which is commonly supposed

to cross the bony opening in the temporal fossa, through which we aim to reach the ganglion; reference is made here to the bone wound suggested by Cushing, it being a little lower as well as smaller than that of Krause. But before the middle meningeal has run so far, it has usually divided once at least; concerning this point of primary division, however, one gains conflicting opinions from the various writers on anatomy. Meckel [53] calls the vessel the " sphenospinal," and remarks that it may divide before it has entered the skull at all, while Wilson,[54] Dursy,[55] and Tillaux [56] seem to be of the opinion that the bifurcation is situated just within the cranial cavity, that is very near the inner terminus of the foramen spinosum. On the other side, Quain,[57] Sappey,[58] McClellan,[59] Spalterholz,[60] Gerrish,[61] and Morris [62] aver that some distance across the floor of the middle fossa is traversed before any division occurs; but Merkel [63] writes that the artery is irregular in this respect, as it may divide at any point in its course. My own observations would go to prove that the last named author alone is correct in his statement, though none of the others are wholly wrong, for in the 100 half-skulls under discussion at least one can be shown in proof of the assertion of every anatomist mentioned.

Not alone is the point of primary division of the middle meningeal irregular, but the farther course of the vessel as well is exceedingly varied in the different skulls; indeed, I was so often impressed by this fact while studying the fossæ in question, that I felt constrained to have photographed eleven specimens which well serve to illustrate the point.

One point of interest to the surgeon, which has been mentioned by Cloquet,[64] is that this vessel, or a part of it, may lie in an actual bony canal instead of in a groove. Division of the continuity of a bone bearing such a canal necessarily involves the operator in a most undesirable predicament; hence the value of knowing that any skull may present such an anomaly. It was encountered but once in the skull-half with which we are engaged. In that one the groove became a closed canal at a point 4.5 centimetres from the foramen spinosum, and

FIG. 1.—The middle meningeal artery, in this case, divides at the internal opening of the foramen spinosum, the anterior branch taking a course internal to the sphenotemporal suture, while the posterior runs outward and backward.

FIG. 2.—Presents a middle meningeal which runs outward and slightly forward a certain distance before it divides. Then the anterior branch takes its course external to the sphenotemporal suture, while the posterior runs outward and slightly backward.

FIG. 3.—The vessel here runs a still greater distance directly outward from the foramen spinosum before dividing. The anterior branch then runs almost directly forward, outside the sphenotemporal suture, and the posterior continues for a time in the direct outward course of the parent trunk.

FIG. 4.—The artery, in this instance, leaves the foramen spinosum in an outward and backward direction; then, after proceeding a little farther than any of its predecessors, divides into two branches. The anterior runs forward and somewhat outward, well external to the sphenotemporal suture; the posterior, however, continues the outward and backward direction assumed by the main trunk.

FIG. 5.—This vessel is the last of its general type. It differs from No. 4 only in that it runs farther from the foramen spinosum before branching.

FIG. 6.—This specimen is peculiar from the fact that it does not branch at all on the floor of the middle fossa. From the time it emerges from the foramen spinosum, it continues in a forward and outward course, lying meanwhile well external to the sphenotemporal suture.

FIG. 7.—The middle meningeal, in this instance, presents a most unusual aspect,—it does not divide on the floor of the fossa; and, furthermore, the vessel, after emerging from a foramen spinosum which is very close to the foramen ovale, takes a course outward and *backward.*

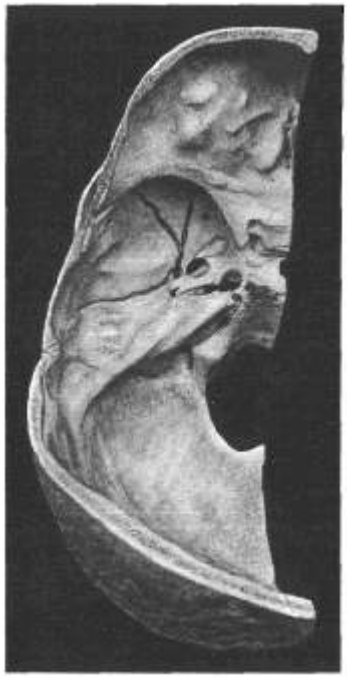

FIG. 8.—The artery is here more complicated in its distribution. Leaving the foramen spinosum, it runs directly forward, but, before proceeding any distance, gives off the branch which usually runs backward and outward. After reaching a point a little in advance of the foramen ovale, it again divides, the external branch running forward and outward, while the internal keeps right on in its anomalous course past the foramen rotundum. One can easily imagine how this last-named branch could have worried the surgeon; having passed the external branch at about the point where we have usually seen the single anterior branch, he would naturally not have expected to find or injure another artery before reaching the foramina.

FIG. 9.—This represents another subject which must have been difficult for the surgeon. Just as it leaves the foramen spinosum, the middle meningeal gives off a branch which takes a course forward and inward past the foramina rotundum and ovale; the main trunk continues outward and slightly backward from the foramen spinosum for a considerable distance, to divide into an anterior and a posterior branch.

FIG. 10.—An operation would here have been easy as far as the middle meningeal is concerned. Almost two centimetres (exactly eighteen millimetres, or nearly one inch) separate the ovale and spinosum —or at least the opening through which the artery passes. The vessel could hardly have been injured in the dissection of the third branch of the trigeminus.

FIG. 11.—Just the opposite condition is here depicted. The middle meningeal could, in this instance, hardly have escaped injury at the point where it enters the skull. It must have been torn at the removal of the third trigeminus branch; for, as the photograph shows, there is an absence of the foramen spinosum,—the artery emerging from the foramen ovale and taking first a course backward, then one outward, and, lastly, one slightly forward.

continued as such over a space within which lies the superior margin of the Cushing bone opening; hence it is clear that this case must have proven a troublesome one for the operation which bears that surgeon's name.

Of no less surgical interest is the condition described by v. Bardeleben [65] in which part of the middle meningeal groove is represented by an actual defect in the bones of the cranial floor; under such circumstances, the vessel would, as a matter of course, be especially exposed to traumata from without. No such anomaly presented itself in my series of skulls; still, I noted in a number of thin-walled specimens that the floor of the groove was apparently no thicker than paper and readily transmitted the light.

Another startling irregularity in the course of this vessel, and one which I have seen mentioned nowhere else, was observed by Dr. Carson,[66] of our city. Here the artery actually left the cranial cavity by a foramen, and, appearing on the outer surface of the skull in the temporal region, was naturally enough torn or cut during the operation.

Supposing, however, the middle meningeal to have escaped injury, there are, besides the venous channels, other sources of hæmorrhage which may prove very serious, unusual vessels with which the surgeon cannot reckon in advance; for instance, the large branches of the internal maxillary artery, which Quain [67] saw enter the cranial cavity through the foramena rotundum and ovale, in a case where there was congenital absence of the internal carotid. It may well serve to make one more careful, in advising or attempting removal of the Gasserian ganglion, to be informed of all these possible conditions.

It is perplexing to note, before leaving the middle meningeal, the various functions which the authors have ascribed to it. Quite a number refer to it in such a way that one might be led to think of it as supplying the dura mater alone. Wilson [68] writes that it furnishes blood to the *bones* of the cranium, while Hyrtl [69] and Heitzmann [70] undoubtedly regard the matter in its true light when they tell us that it is the feeder of certain bones as well as a part of the dura.

It had been my hope, in undertaking this subject, to be able to formulate some rule for avoiding this artery in making the bone opening necessary to a removal of the Gasserian ganglion. This is, however, manifestly impossible in dealing with a structure which is so irregular that in 100 middle fossæ it can hardly be said to follow identically the same course in any two. Not possessing an ideal routine, it is then next in importance that we realize the possibility of meeting the artery at almost any point in the temporal fossa,—it may be lying upon the inner surface of the bone, embedded within the same, or, in rare instances, outside the protecting wall.

In determining the various average dimensions of the field of operation, in depicting certain anomalies of the middle meningeal artery, and in calling attention to the fact that this vessel is most easily avoided at the point where it enters the cranial cavity, in those cases which have the second and third branches of the trifacial closest together, something has, I trust, been done towards perfecting and rendering more safe the difficult procedure which offers victims of trigeminus neuralgia their only hope of permanent relief.

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